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REPORT OF THE CHEMIST.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY,
Washington, D. C., October 1, 1915.

SIR: I submit herewith the report of the work of the Bureau of Chemistry for the fiscal year ended June 30, 1915.

Respectfully,

CARL L. ALSBERG,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

New investigations in connection with the application of chemistry to agriculture and the development of a systematic plan of inspection in connection with the enforcement of the Federal food and drugs act increased very largely the volume of work done by the Bureau of Chemistry during the fiscal year.

The research work, which has heretofore been confined largely to problems arising in connection with law enforcement, was extended to include work designed to prevent spoilage and waste and to increase production.

The experience of the bureau in the administration of the Federal food and drugs act shows that violations of its provisions are quite as frequently the result of ignorance of proper methods of production as of willful intent. The effort which has been made to improve old and devise new methods of production has proved to be an important factor in securing compliance with the law. The results obtained have been communicated to manufacturers and producers through cooperative experiments and publications.

The research work has been divided so as to segregate investigations in reference to food adulteration from investigations of new methods of production and new methods of utilizing products of the soil and sea. In both, there has been increased activity, and it is contemplated that in the near future research work in agricultural chemistry, which in recent years has been overshadowed by the demands of regulatory work, will take an equally important place in the duties of the bureau.

RESEARCH.

FLORA OF FOODSTUFFS.—A laboratory of microbiology was established for the purpose of further developing work upon the decomposition and fermentation of food products. In this laboratory a comparative study was undertaken of the groups of species of molds,

their natural or usual habitats, and the changes induced by them in foodstuffs. With this was combined a study of related forms. The results of the study of the *Penicillium luteum purpurogenum* group have been published. A study of corn silage and corn meal was begun. This work supplements work previously completed and published in Department Bulletin No. 215, "Composition of Corn (Maize) Meal Manufactured by Different Processes and the Influence of Composition on the Keeping Qualities."

Plant chemistry.—To form a basis for practical nutrition investigations the composition of vegetable proteins and the forms in which nitrogen occurs in plants were studied. The prussic-acid content of various forage and medicinal plants was determined by an improved method which has been published. Among other plant chemical problems, the properties of saponin and saponin-bearing plants were investigated, and special attention was given to medicinal plants containing emodin for the purpose of improving analytical methods. A new volatile oil has been isolated from the flowers of the cotton plant and examinations have been made of the glucoside found in its leaves. The work done by the bureau in connection with this plant was for the purpose of assisting the Bureau of Entomology in its boll-weevil investigations.

Analyses were made of the different varieties of American forage grasses, and a report on their composition was made to the Bureau of Plant Industry for use in the preparation of the bulletin, "Native Pasture Grasses of the United States."

Investigations of the bureau in connection with the production, botanical composition, and volatile-oil strength of American wild mustard seed and the hydrogen number of the essential oils of sassafras, anise, fennel, clove, and pimenta have been published.

Vegetables and fruits.—Experiments in the drying of potatoes on a commercial scale were begun during the year. Preliminary experiments were made in methods of manufacturing potato starch, glucose, and dextrin and in practical methods of ensiling potatoes. The propagation of desirable lactic-acid bacteria for inoculation of ensilage was commenced.

Some of the results of the experiments and investigations in connection with the utilization of surplus fruit were published in Department Bulletin 241, "Studies on Fruit Juices," and in a Yearbook article on "Apple Sirup and Concentrated Cider."

Studies were continued in California on the ripening of oranges. A tentative standard for determining maturity, based upon the ratio of acids to solids, proposed by the bureau, was generally adopted by the orange growers.

Attention was given to the development of methods of manufacturing citric acid, lemon oil, orange juice, orange vinegar, and other by-products of citrus fruits.

In cooperation with the Bureau of Plant Industry the composition of oranges and lemons from selected trees was determined, with the object of making selections in propagation experiments.

Investigations of the mottled-leaf disease of citrus trees, in cooperation with that bureau, demonstrated that such trees, in addition to lime, require considerable organic matter, which may be best supplied through green manuring.

Experiments in relation to the absorption by crop plants of boron applied to the soil through manure treated with borax to destroy the larvæ of the housefly were completed. The results of these investigations are in the course of preparation for publication.

Shellfish and fish.—A new method was devised for the bacteriological examination of shellfish. In cooperation with food officials of interior States, investigations and experiments were conducted regarding the bacteriology of shucked oysters. It was discovered that a yeast was the probable cause of the reddening which affected thousands of gallons of oysters during the past season. A method was devised for determining the adulteration of scallops with water. In cooperation with the Bureau of Fisheries, investigations were commenced in regard to the freezer storage of fish treated in various commercial ways. Complete analyses of many fish were made. Continuance of the sardine investigations resulted in a further improvement in the quality of the pack. Methods for utilizing waste in the sardine industry were recommended. In cooperation with the Bureau of Animal Industry, the feeding value of fish meal was determined.

Poultry and eggs.—Nutrition investigations were commenced to determine the best methods of feeding poultry, after receipt by the packer, for increase in weight and in quality. Studies upon the breakage of eggs in transit were the basis of definite recommendations to the industry on bracing eggs in cases, bracing cases in cars, and bracing, buffing, and shifting cars in transit. The adoption of these recommendations has largely decreased damage in transit. Department Bulletin 51, "A Bacteriological and Chemical Study of Commercial Eggs in the Producing Districts of the Central West," was published. Demonstration work in the transportation, storage, and general handling of dressed poultry and eggs was extended to new territory in Oklahoma, Kansas, and Indiana. A partial description of this work was published in a Yearbook article, "The Egg and Poultry Demonstration Car Work in Reducing our $50,000,000 Waste in Eggs."

Insecticides and fungicides.—Several new lead arsenates and lead-chlorarsenates were prepared and their properties studied. The cause of injury to foliage by di-lead-arsenate—of which several thousand tons are used annually for spraying purposes—was found to be due, in many cases, to its decomposition by salts that occur naturally in the waters which are used for its application. A lead arsenate which is stable under these conditions was prepared. This is now being tested by the Bureau of Entomology to determine its efficiency for spraying purposes.

In cooperation with the Federal Horticultural Board, a method was devised of fumigating cotton bales with hydrocyanic acid gas, in order to guard against the introduction into this country of the pink bollworm through the importation of Egyptian cotton.

In cooperation with the Bureau of Entomology, it was found that hellebore is a practical and effective larvicide for preventing the development of the house fly in manure without affecting its fertilizing value. A summary of this work, with similar work of the preceding year, was published in Department Bulletins 118 and 245.

Salt.—A practical method was devised, and is now in use, to remove barium chlorid from brines in the manufacture of salt.

Pharmacological investigations.—Investigations upon the pharmacology of the organic acids were continued, and some of the data upon citric, tartaric, and oxalic acids were published. A thorough study of the oil of chenopodium was completed and published. This oil, advocated in hookworm disease, was found to be quite toxic. Much attention was paid to the pharmacology of water-soluble and fat-soluble dyes used in foods.

Sirup—Sugars.—Important progress was made in investigations for the improvement of the methods of manufacture of cane sirup in order to obtain a uniformly bright sirup that will not ferment. A similar investigation for the improvement of sorghum sirup was commenced. Investigations to improve the methods of manufacture of candy, jams, preserves, jellies, and marmalades were continued. Improved methods were devised for the preparation of a number of sugars. A method of preparing raffinose has been published. The mutarotation of the sugars was under investigation and the rotatory power of a series of sugars and sugar derivatives was accurately determined. Some of these investigations, as well as others upon the action of enzymes upon sugars, have been published. The following new compounds were prepared and made the subject of publications: The second, third, and fourth pentacetates of galactose, the alpha tetracetate of xylose, the alpha pentacetate of mannose, and the alpha and beta pentacetates of fructose.

Dust explosions.—Large property losses occur annually from dust explosions in the thrashing and milling of grain. It is reported that during the year 1914 more than $1,000,000 worth of property was destroyed in thrasher explosions in the States of Washington, Idaho, and Oregon. In cooperation with the Bureau of Mines and the Office of Public Roads and Rural Engineering, these explosions, as well as mill and elevator explosions, were investigated and means were devised which it is believed will render these accidents less frequent. Incidentally, observations were made for the Bureau of Mines upon the explosiveness of dusts.

Leather and tanning.—Methods for the determination of sugar in leather and for the detection of oak in tanning extracts and leathers were published. Much work was done to devise methods to determine the durability of leathers. Studies were made and published on the purification and disposal of tannery wastes.

Cereals.—Microchemical, chemical, and baking investigations were commenced to devise methods for the examination of the various grades of flour. Experiments upon flour substitutes and upon the methods of wrapping bread were also undertaken, and some of the results have been published. Owing to climatic conditions, the rye crop contained an unusual amount of ergot. Rye products were therefore studied with a view to devising better methods for the detection of ergot in them.

Analytical methods.—Methods for the estimation of caffein and antipyrin in admixture, the estimation of antipyrin, the estimation of phenacetin and salol in admixture, and the electrolytic separation

and determination of zinc, copper, and iron in the presence of arsenic, and studies of the ash and acidity of vanilla extracts have been published.

Studies were made of the determination of lead in baking powder, of the Kjeldahl method of determining nitrogen, of the determination of arsenic and tin in canned goods, of the determination of moisture in foods, of mercury in surgical dressings, of pepsin in chewing gum, of ethyl nitrite in sweet spirits of niter, of lime in butter made from limed cream, and of citric acid in the presence of other organic acids. New methods for the analysis of vinegars and of aromatic spirits of ammonia were under consideration.

REGULATION.

Domestic foods and drugs.—The reorganization of the bureau's field service into three districts, outlined in the bureau's report for the year ended June 30, 1914, resulted in more efficient inspection of foods and drugs moving in interstate and foreign commerce and in more systematic action in the administration of the Federal food and drugs act.

Special attention was given during the year to interstate traffic in adulterated pepper. Pepper shells have been imported in large quantities and utilized as an adulterant for ground whole pepper. The distribution of the shells was investigated, factories were inspected, and many samples of the raw and the finished product were analyzed. Through the collection and analysis of products of particular manufacturers over a considerable period of time it appeared in many cases that the adulteration was deliberate and extensive and not an accident or due to a single instance of carelessness. Seizures of a very considerable number of interstate deliveries brought forth assurances that mixtures of pepper and pepper shells will hereafter not be sold merely as pepper, but if sold at all will be truthfully described on the label.

Adulteration of oats by the deliberate addition of barley, weed seeds, or water also was investigated. A large number of consignments were seized, with the result that the practice has been largely discontinued.

An extensive investigation was made of the coffee trade. It was found that certain merchants were mixing shipments of high-grade coffee with cheaper and inferior brands, and shipping and selling the mixture to the trade throughout the country as coffees of the higher and more expensive grades. After considerable inspection work, the practice, which was widespread and successful because of the inability of the vendee ordinarily to determine for himself the actual grades of coffee, has been largely corrected.

Among the many forms of adulteration of foods that have received special attention are the adulteration of canned tomatoes with water, of dried apples with water, and of cider vinegar with distilled vinegar; the canning of decomposed cull beans; and the manipulation of smutty barley by liming.

In cooperation with the Bureau of Standards, extensive experiments were undertaken with a view to establishing special "tolerances and reasonable variations" under the net-weight amendment

to the food and drugs act. The study of dairy products is nearly completed and the results will soon be published.

Special attention was given to medicines and mineral waters bearing false and fraudulent labels. Fifty-six cases based upon such violations of the act have been disposed of in the courts favorably to the Government. Many more cases of this type are pending.

The reorganization of the field service has also led to closer cooperation with State and municipal officials. An example of such cooperation was the campaign conducted against the traffic in discarded or rejected shell eggs. These eggs, as a rule, contained a very large proportion of completely decomposed eggs and of other eggs in various stages of spoilage, with a certain proportion of fairly satisfactory eggs which might be suitable for breaking and preparing dried or frozen eggs. Cooperation with the State and municipal officials of Illinois was effective in suppressing commerce in eggs of this type. For the purpose of saving the small percentage of edible eggs which are sometimes present in these shipments, a conference was held with the egg trade and with a special committee of the National Association of State, Dairy, and Food Commissioners. As a result of this conference the State of Illinois passed a special act regulating the handling of this class of eggs, requiring that it be done in establishments entirely under its control, prohibiting traffic in eggs which are known to be bad, and regulating very carefully the traffic in eggs which might be classed as doubtful. A similar regulation of this class of eggs has been established in the State of Kansas. The general effect of this cooperation between Federal, State, and municipal officials has been to bring about a much improved condition in the trade.

Similar cooperation was undertaken in conjunction with the food commissioners of the States of Illinois, Iowa, Missouri, Kansas, and Nebraska, and the Bureau of Animal Industry, for the purpose of improving the milk supplies of the small cities near State boundaries. Temporary headquarters were established in the towns in which the milk supply was to be investigated and, with the aid of the State chemists and inspectors and the city officials, thorough surveys were made of the milk supply of each town. In cases in which the milk was found to be very dirty or high in bacterial count or watered and skimmed, a special visit was paid by the inspectors, in company with the dairy expert of the Bureau of Animal Industry, to the farms from which the milk came. This party made a sanitary survey of the dairy, suggesting to the farmer possible improvements which might enable him to produce a more satisfactory quality of milk. In those cases in which chemical examination indicated adulteration or misbranding, due either to watering or skimming, a test was made of the milk from the herd. The milk shipments from these farms were then again examined later and as a rule a marked improvement in quality was found. This plan has the advantage over those usually pursued in that results are more permanent. Milk producers learn how to improve methods and State and municipal officials continue the work, thus leading to the permanent improvement of the milk supply.

In cooperation with the commissioners of various States, the Public Health Service, and the oyster industry, the sanitary survey of

oyster beds which has been in progress for two years has been continued on the North Atlantic coast. It is leading to a more satisfactory control of the traffic in oysters from polluted waters. This work was extended to the interstate traffic in clams from polluted sections in New England.

The work of the Office of State Cooperative Food and Drug Control has been an important factor in making the cooperative work of the bureau effective. The establishment of this office was discussed in this report for the year ended June 30, 1914. Conferences have been held with all but one or two of the food, drug, and feed officials of the States. The State officials have been notified of such violations of their own laws as have been noted by Federal inspectors in the course of their regular work. State officials have been encouraged to take advantage of the authority conferred upon them by the Federal act to institute proceedings against illegal products upon their own initiative. Such a course is particularly desirable when quick action is demanded, as in the case of spoiled or decomposed perishable food products. The direct result has been that a considerable amount of such material has been barred by State authorities from sale as human food.

For a number of years a mass of information of the greatest value in the enforcement of the food and drugs act has been accumulating in the files of the Bureau of Chemistry, but it has not been in a form available for use in the bureau or elsewhere. This material is being carefully prepared so that it may be readily used and distributed to State officials.

The office of State cooperative food and drug control has also largely assisted the joint committee on definitions and standards. The organization and functions of this committee were described in this report for the year ended June 30, 1914. This committee has considered standards and definitions for flours and meals (exclusive of feeds), nonalcoholic and carbonated beverages, milk products, cocoa and chocolates, dried fruits, edible cereal pastes, gluten products and diabetic foods, soda flavors, and maple products. It has proposed standards and definitions for cacao products, gluten products and "diabetic" foods, macaroni, spaghetti, vermicelli, and similar alimentary pastes, egg noodles and plain noodles, condensed milk or evaporated milk, and maple products.

During the year a Food Inspection Decision, No. 158, based upon the recommendation of the committee, defining condensed milk, evaporated milk, or concentrated milk, was issued.

Seventy-nine opinions in the form of letters or rulings were published during the year in the Service and Regulatory Announcements.

Inspection.—Official samples numbering 4,412, besides 873 unofficial samples, were analyzed. Check analyses were made of 269 official samples. The number of samples analyzed is considerably less than in former years, because through cooperation between inspectors and laboratories incident to the reorganization of the bureau the collection of samples has been systematized and the collection of duplicate samples has been avoided to a greater extent than heretofore. There has also been less duplication of analytical work in

the laboratories. The following table shows the number of analyses of interstate samples at each laboratory in each inspection district:

Examination of interstate samples.

Laboratory.	Samples analyzed.	Check analysis samples.	Total number of interstate analyses.
Eastern district:			
Boston	273	.....	273
Buffalo	219	1	220
New York	516	28	544
Philadelphia	107	1	108
Porto Rico	14	.....	14
Savannah	199	5	204
Washington	290	7	297
Total	1,618	42	1,660
Central district:			
Chicago	1,041	145	1,186
Cincinnati	446	9	455
New Orleans	181	1	182
St. Louis	428	16	444
St. Paul	169	28	197
Total	2,265	199	2,464
Western district:			
Denver	174	2	176
Honolulu	16	.....	16
San Francisco	214	26	240
Seattle	125	.....	125
Total	529	28	557
Grand total	4,412	269	4,681

While the number of samples collected during the year was less than in previous years, the percentage of violations noted in the samples collected was greater than in previous years. This is believed to be due to closer supervision exercised over the collection of the samples.

As a result of the inspection work of the bureau, 491 recommendations for seizures and 276 recommendations for criminal prosecution were made through the office of the solicitor to the Department of Justice. In addition, evidence of conspiracies to violate the Federal food and drugs act was presented directly to some of the United States attorneys. In one case convictions and the imposition of large fines resulted. Information was also furnished to representatives of the Department of Justice of apparent violations of section 240 of the Penal Code.

Special attention was given to the inspection of foods and drugs shipped into Alaska, both at points of origin and at points of destination.

Importations.—Shipments of food and drugs offered for importation into the United States numbering 103,343 were examined. Of these shipments, 7,744, comprising 6,713 shipments of food and 1,031 shipments of drugs, were denied entry. Of the total number of shipments examined, 20,238 samples were analyzed in laboratories and 83,105 samples received floor inspection.

The work done on import samples by each laboratory in each district is shown by the following table:

Examination of import samples.

Laboratory.	Samples analyzed.	Samples inspected on floor.	Total import samples.
Eastern district:			
Boston	1,379	11,848	13,227
Buffalo	345	113	458
New York	10,458	37,003	47,461
Philadelphia	842	3,721	4,563
Porto Rico	676	2,766	3,442
Savannah	188	30	218
Washington	23	0	23
Total	13,911	55,481	69,392
Central district:			
Chicago	643	3,131	3,774
Cincinnati	1,611	324	1,935
New Orleans	438	2,023	2,461
St. Louis	88	561	649
St. Paul	115	292	407
Total	2,895	6,331	9,226
Western district:			
Denver	103	119	222
Honolulu	556	3,925	4,481
San Francisco	1,699	11,788	13,487
Seattle	1,074	5,461	6,535
Total	3,432	21,293	24,725
Grand total	20,238	83,105	103,343

The number of importations allowed entry after relabeling was unusually large, on account of the fact that a very large number of shipments were detained for failure to comply with the net-weight amendment to the Federal food and drugs act, which took effect during the year. Partly because of this amendment, partly because more attention was paid to the supervision of importations at ports on the Pacific coast, and partly because of abnormal trade conditions, the number of shipments examined was nearly 2,500 in excess of the number examined during the fiscal year ended June 30, 1914.

An effective campaign of inspection was conducted along a part of the Canadian frontier to prevent the importation into the United States of adulterated milk and cream.

MISCELLANEOUS EXAMINATIONS.

In addition to import samples and interstate samples, the field laboratories of the bureau analyzed a large number of miscellaneous samples. The following table shows the number of miscellaneous samples analyzed by each laboratory in each district, together with the total number of samples of all classes analyzed in each laboratory of each district.

Examination of miscellaneous samples.

Laboratory.	Miscellaneous samples analyzed.	Total samples analyzed.
Eastern District:		
Boston	192	1,844
Buffalo	55	620
New York	187	11,189
Philadelphia	46	996
Porto Rico	5	695
Savannah	34	426
Washington	37	357
Total	556	16,127
Central District:		
Chicago	539	2,368
Cincinnati	347	2,413
New Orleans	61	681
St. Louis	156	688
St. Paul	622	934
Total	1,725	7,084
Western District:		
Denver	203	482
Honolulu	6	578
San Francisco	220	2,159
Seattle	244	1,443
Total	673	4,662
Grand total	2,954	27,873

STANDARDIZATION AND COLLABORATION.

The standard type samples for the grading of rosin, prepared by the Bureau of Chemistry, were adopted by the boards of trade of Savannah, Ga.; Jacksonville, Fla.; Pensacola, Fla.; and Mobile, Ala.; the produce exchanges of New York City and New Orleans, La., and the State of Florida. Independent producers, dealers, and consumers generally also adopted these standards. These types have thus become the recognized standards on which all rosin transactions are based. It was contemplated that the glass types should be used in all grading, but it was impossible to secure enough of the proper material from European countries, with the result that a sufficient number of standards is not yet available. The glass standards, therefore, have been used mainly for the preparation of rosin types. Examinations of these types by the bureau have shown less variation than existed before the glass standards were issued. The agreement with the standard, however, is not entirely satisfactory, as the bureau has frequently pointed out, owing to the great difficulty in obtaining rosin precisely on the standard and to difficulty in cutting the pieces of rosin.

Collaboration with the University of Idaho on the chemical utilization of Idaho woods, begun during the previous fiscal year, was continued.

For other bureaus of the Department of Agriculture 10,292 samples were analyzed by the laboratories in Washington, while 1,596 samples were analyzed for other executive departments and Government establishments, making a total of 11,888 samples. This total does not include samples that were analyzed by the branch laboratories of the field service of the bureau.

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